


Emerging Contaminants in Drinking Water Sources

Korkud Egrican, P.E.

Montgomery County Water Quality Advisory Group

June 8, 2015

Outline

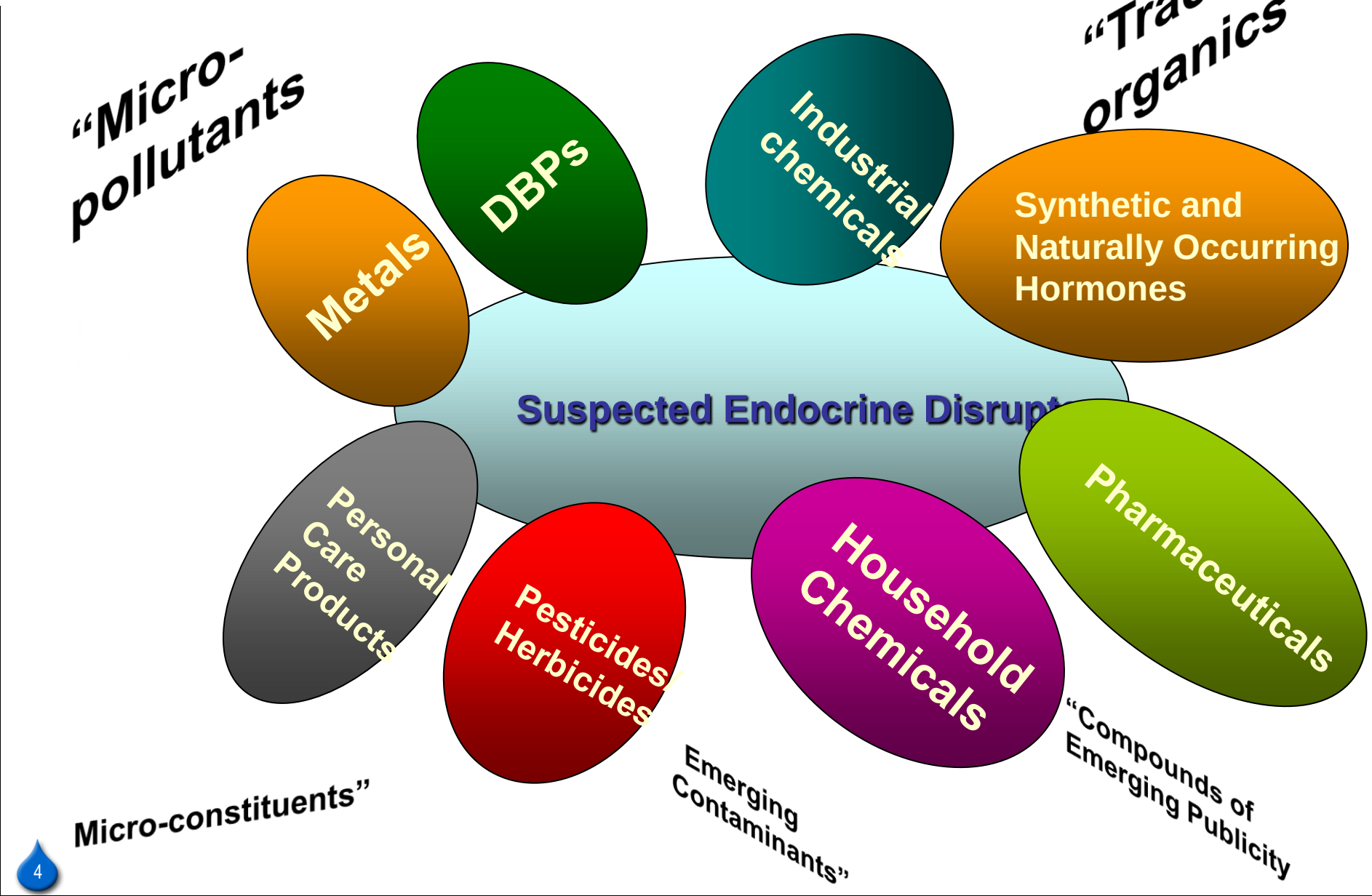
- Emerging contaminants/endocrine disrupting chemicals (EDCs)
- Source pathways for EDCs
- Ecological effects of EDCs
- Treatment processes for EDCs
- Future regulations
- Closing thoughts

Endocrine Disrupting Chemicals (EDCs)

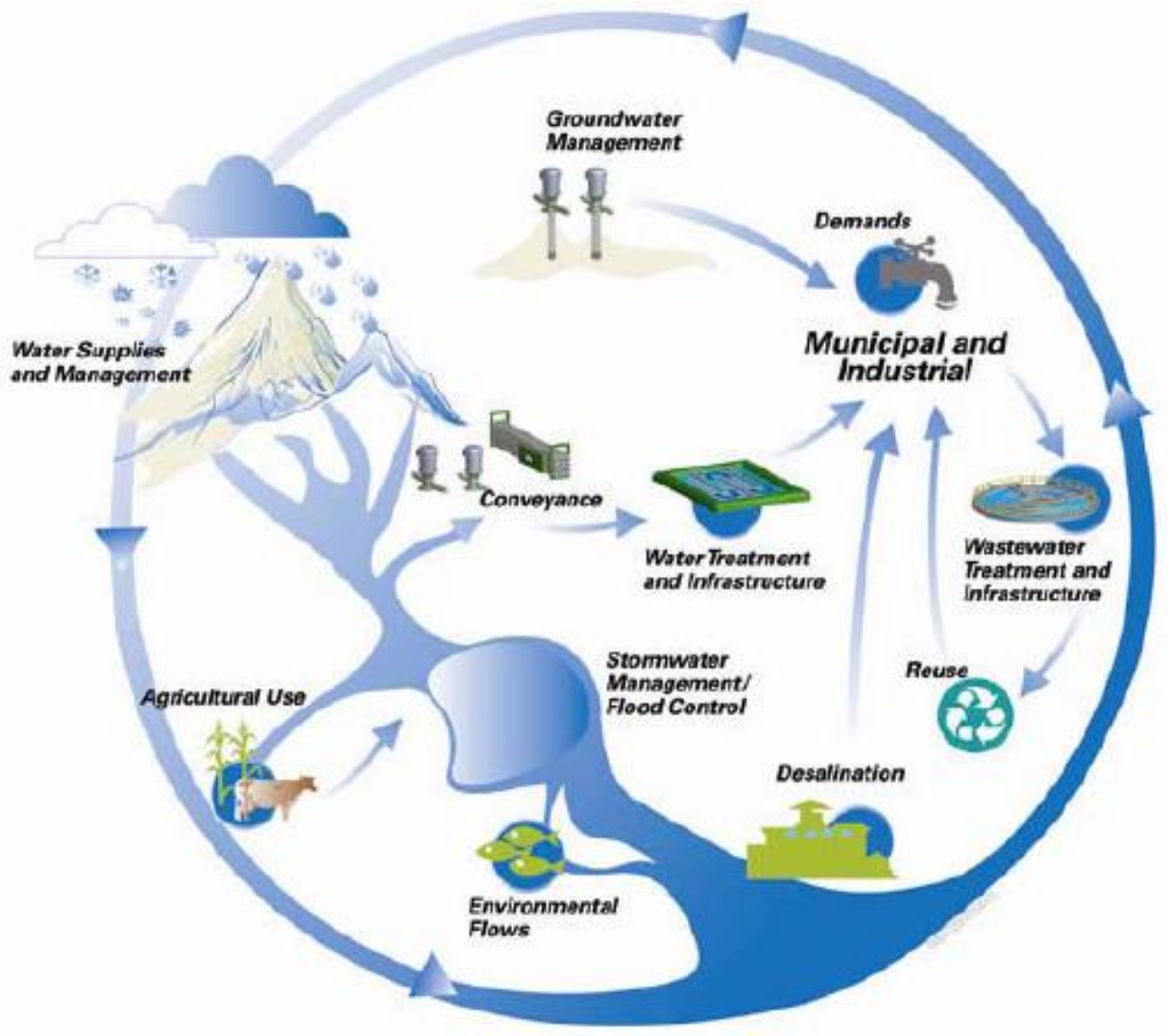
- EDCs are substances that can affect the endocrine system in humans or animals
- Endocrine system: Network of glands that produce hormones to regulate biological processes
- EDCs are a big group of chemicals that impact estrogen, androgen, and/or thyroid hormone functions
- EDCs can be natural or manmade chemicals

Compounds of Emerging Concern

(Source: Dr. Jorg Drewes, Colorado School of Mines)

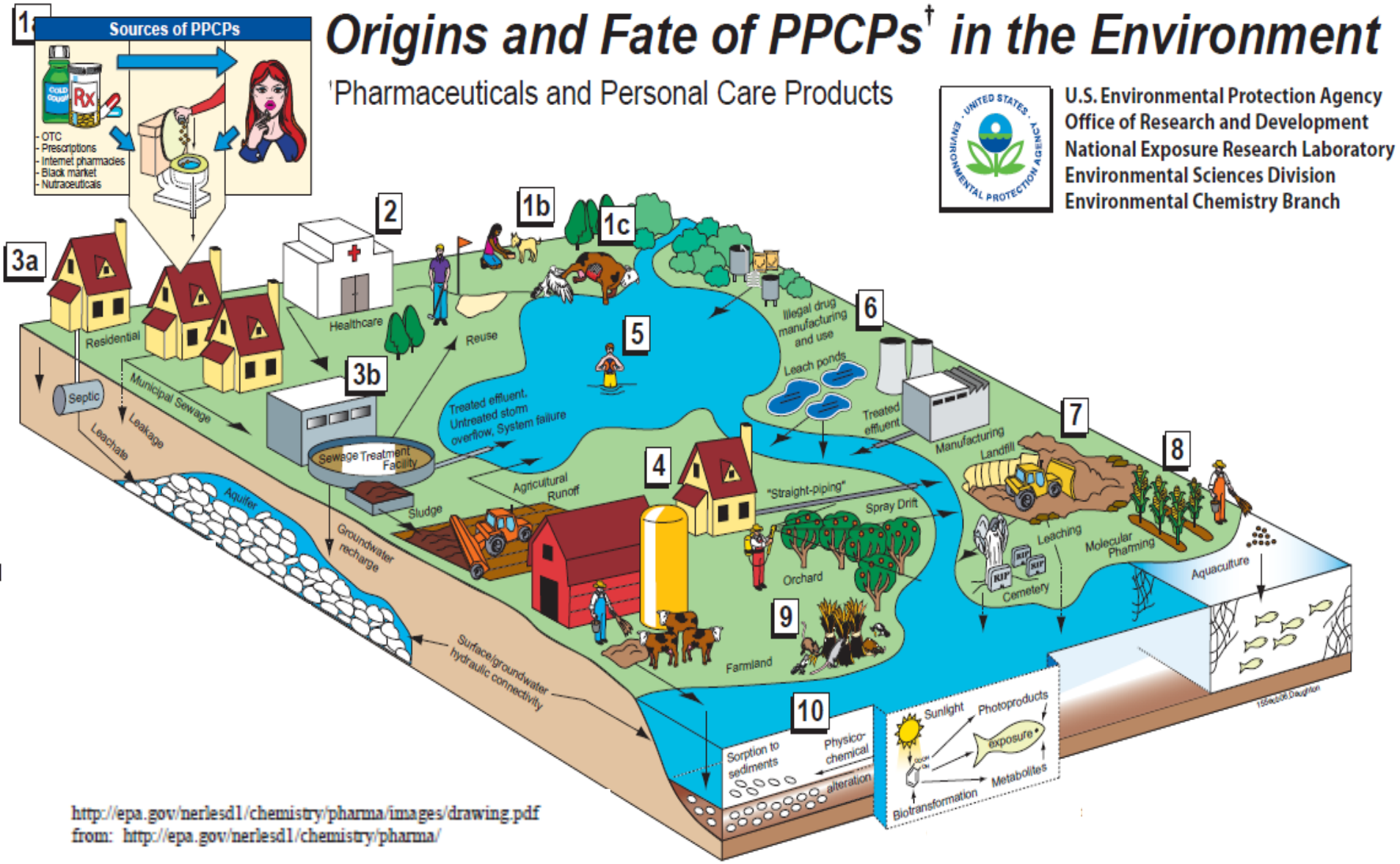


Our Watersheds Have Multiple Purposes and Uses



Holistic solutions that necessitates an integrated approach to the EDC issue involving the built and natural components of the water cycle.

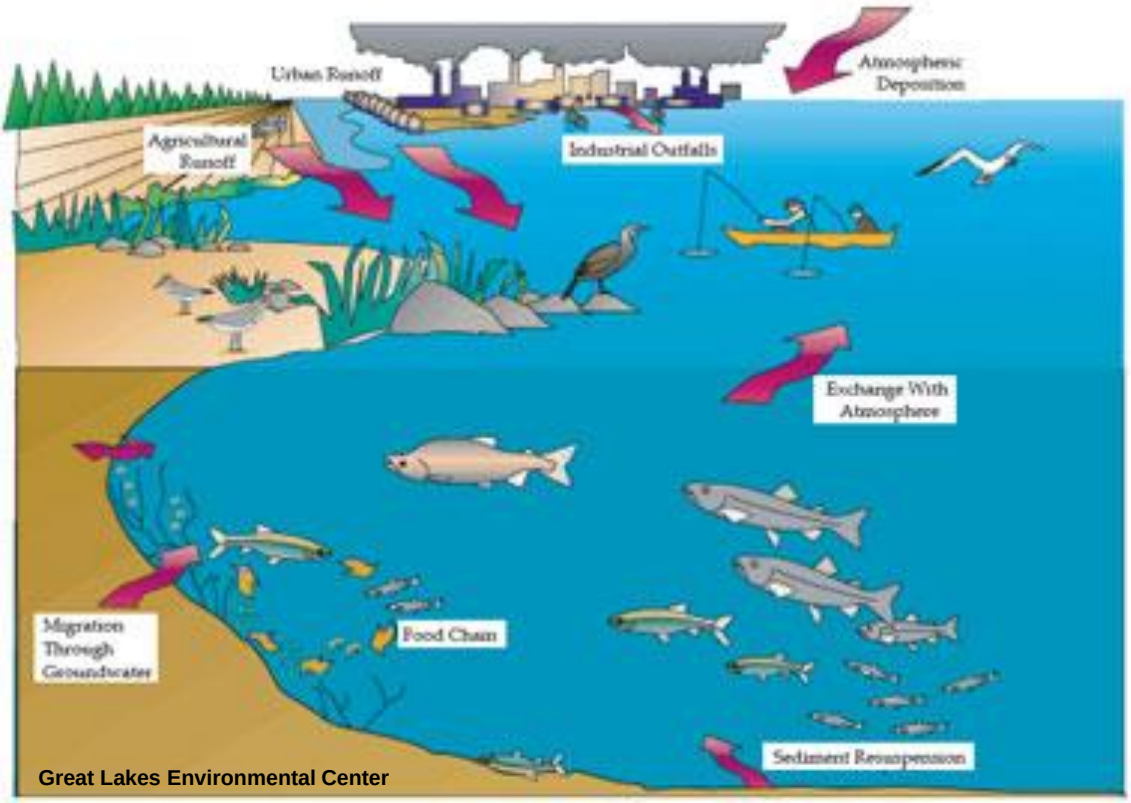
Sources and Source Pathways of EDCs in the Environment

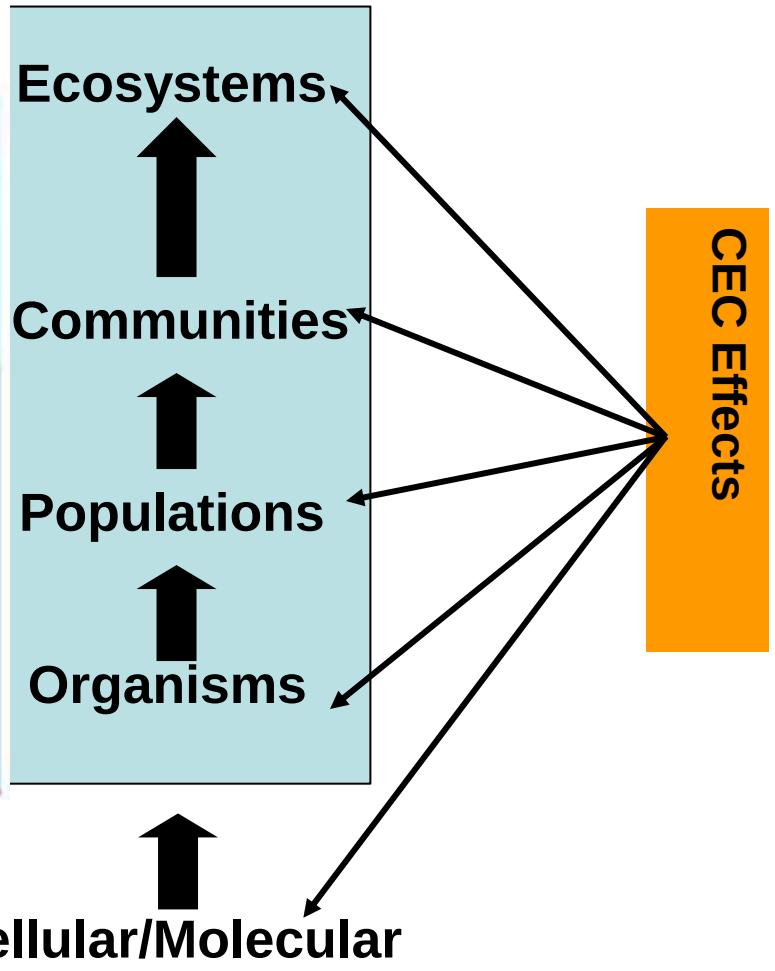


http://epa.gov/nerlesd1/chemistry/pharma/images/drawing.pdf
from: http://epa.gov/nerlesd1/chemistry/pharma/

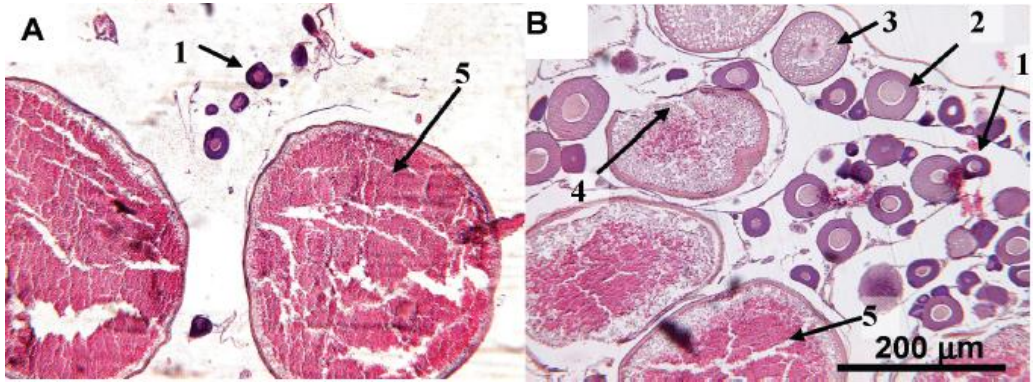
Ecological Effects of : Need to Understand Hierarchy of CECs Ecological Organization

An Urban Aquatic Ecosystem

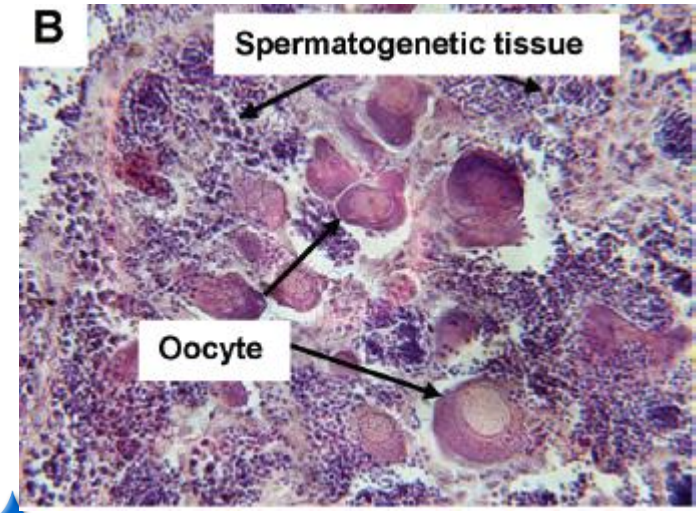




Example: Effects of Endocrine Disruption on Reproduction of White Suckers, CO.



Upstream of Effluent Downstream of Effluent



Female fish in effluent dominated downstream site exhibited asynchronous ovarian development

18-22% of the fish in effluent dominated downstream site were intersex fish (exhibited both male and female gonads) – Potential impairment of reproductive fitness

Source: Vajda et al. (2007) Environmental Science & Technology 42: 3407-3412

EDCs are Detected at Low Concentrations

- EDCs are now being identified in water at very low levels,1 ng/L (1 part per trillion)
- Analytical chemistry capabilities
- 1 part per trillion represents:
  - 1 second in 31,688 years
  - 1 drop of water in 20 Olympic-size swimming pools

EDCs Are Making News

- **"Pharmaceuticals in Our Water Supply Are Causing Bizarre Mutations to Wildlife " -** E Magazine, August 9, 2007
- **"Pharmaceuticals lurking in U.S. drinking water: AP probe found traces of meds in water supplies of 41 million Americans" -** AP, March 10, 2008
- **"Tons of Released Drugs Taint U.S. Water"** – U.S. News & World Report, April 19, 2009

- Growing public concern regarding these compounds

Top 11 Pharmaceuticals and Hormonally-Active Compounds in U.S. Drinking Water

- Atenolol – Beta-blocker used to treat cardiovascular disease
- Atrazine – Organic herbicide
- Carbamazepine – Mood-stabilizing drug used to treat bipolar disorder
- Estrone – Estrogen hormone
- Gemfibrozil – Anti-cholesterol drug
- Meprobamate – Tranquilizer used in psychiatric treatment
- Naproxen – Painkiller and anti-inflammatory
- Phenytoin – Anti-convulsant used to treat epilepsy
- Sulfamethoxazole – Antibiotic used against Streptococcus bacteria
- TCEP – Flame retardant
- Trimethoprim – Antibiotic

Source: Study of drinking water from 19 utilities (serving 28 million Americans) by Benotti et al., Environ. Sci. Technol., **2009**, *43* (3), pp 597–603

Current Regulations for EDCs

- Existing EPA limit for atrazine (0.003 mg/l)
- Primacy agencies have their own limits for several compounds
- California has set draft groundwater recharge requirements for indirect potable reuse.
  - Contaminant monitoring, including several pharmaceuticals
  - Treatment requirements (NDMA and 1,4-dioxane)

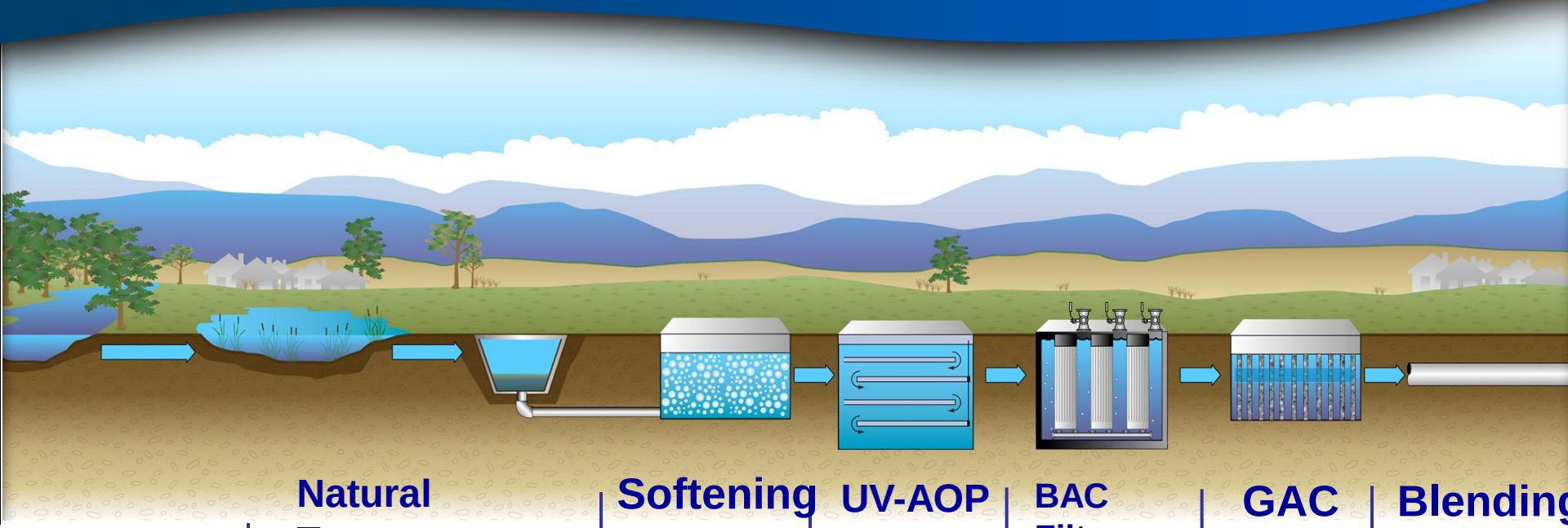
Removal at Water Treatment Facilities

- Every compound is different and different processes address different compounds
- Multiple-barrier treatment approach → Best approach to address these compounds
- Treatment trains combining advanced processes are the most effective for removing trace concentrations of EDCs

Treatment Options for EDCs

- Coagulation/Flocculation
- Activated Carbon (GAC and PAC)
- Chlorination
- Ozonation (and AOP with peroxide)
- UV (and AOP with peroxide)
- Membranes (RO, NF)
- Magnetic Ion Exchange (MIEX)
- Biological Processes
  - Biologically active filters
  - Riverbank filtration
- A train combining any of these processes

Combining the Best Natural and Engineered Steps as Multiple Barriers



	Natural Treatment	Softening	UV-AOP	BAC Filters	GAC	Blending
Taste and Odor	✓	✓	✓		✓	
Color	✓	✓	✓			
TDS						✓
Nitrate	✓					
Pathogens	✓		✓	✓		
Organics	✓	✓			✓	
Micro-Pollutants	✓		✓		✓	

Future Regulatory Outlook for EDCs

- The SDWA mandates three conditions for a regulation:
  - Compound may have an adverse health effect
  - Known or likely to occur at levels of concern
  - Regulation offers meaningful opportunity for risk reduction
- EPA has a four-pronged approach for EDCs:
  - Strengthen the science
  - Improve public understanding and risk communication
  - Build partnerships for stewardship
  - Use existing regulatory tools (CCL and UCMR)
- Not adequate extended health effects data
- Too many compounds to regulate one-by-one

Summary

- Currently no regulations for EDCs
- EDCs can be reduced by conventional treatment
- There is no treatment that will remove all EDCs – requires a combination of processes
- Public health benefit and cost balance is important to consider → best use of public funds
- Important for utilities to put in plans to put in advanced processes to address future public concerns for EDCs.


Questions????